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10 August 1992  
SUPERSEDING  
MIL-A-46027G(MR)  
6 January 1984

## MILITARY SPECIFICATION

### ARMOR PLATE, ALUMINUM ALLOY, WELDABLE 5083 AND 5456

This specification is approved for use by the US Army Materials Technology Laboratory, Department of the Army, and is available for use by all Departments and Agencies of the Department of Defense.

#### 1. SCOPE

1.1 Scope. This specification covers 5083 and 5456 wrought aluminum alloy armor plate which is weldable and has ballistic properties meeting the requirements of this specification. The nominal thickness of armor plate covered by this specification is one-quarter to three inches, inclusive.

#### 2. APPLICABLE DOCUMENTS

##### 2.1 Government documents.

2.1.1 Specifications, standards, and handbooks. The following specifications, standards, and handbooks form a part of this document to the extent specified herein. Unless otherwise specified, the issues of these documents are those listed in the issue of the Department of Defense Index of Specifications and Standards (DODISS) and supplement thereto, cited in the solicitation (see 6.2).

#### STANDARDS

##### FEDERAL

FED-STD-151 - Metals; Test Methods

##### MILITARY

MIL-STD-129 - Marking for Shipment and Storage

#### SPECIFICATIONS

##### FEDERAL

AAA-PFE-1 - Aluminum Alloy Armor - Plate, Forged, Extruded

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Beneficial comments (recommendations, additions, deletions) and any pertinent data which may be of use in improving this document should be addressed to: Director, U.S. Army Laboratory Command, Materials Technology Laboratory, ATTN: SLCMT-MEE, Watertown, MA 02172-0001 by using the Standardization Document Improvement Proposal (DD Form 1426) appearing at the end of this document or by letter.

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## STANDARDS

### FEDERAL

FED-STD-151B - Metals; Test Methods (see pg 639 DODISS Numerical)

### MILITARY

MIL-STD-129 - Marking for Shipment and Storage

(Unless otherwise indicated, copies of federal and military specifications, standards, and handbooks are available from the Standardization Documents Order Desk, Bldg. 4D, 700 Robbins Avenue, Philadelphia, PA 19111-5094.)

2.2 Non-Government publications. The following documents form a part of this specification to the extent specified herein. Unless otherwise specified, the issues of the documents which are DoD adopted are those listed in the issue of the DODISS cited in the solicitation. Unless otherwise specified, the issues of documents not listed in the DODISS are the issues of the documents cited in the solicitation (see 6.2).

### AMERICAN NATIONAL STANDARD INSTITUTE (ANSI)

ANSI-H35.2 - Dimensional Tolerances For Aluminum Mill Products

(Application for copies should be addressed to the American National Standards Institute, 1430 Broadway, New York, NY 10018.)

### AMERICAN SOCIETY FOR TESTING AND MATERIALS (ASTM)

ASTM B557 - Tension Testing Wrought and Cast Aluminum and Magnesium-Alloy Products

ASTM G47 - Determining Susceptibility to Stress-Corrosion Cracking of High Strength Aluminum Alloy Products

(Application for copies should be addressed to the American Society for Testing and Materials, 1916 Race Street, Philadelphia, Pennsylvania 19103.)

(Technical society and technical association specifications and standards are generally available for reference from libraries. They are also distributed among technical groups and using Federal agencies.)

2.3 Order of precedence. In the event of a conflict between the text of this document and the references cited herein, the text of this document takes precedence. Nothing in this document, however, supersedes applicable laws and regulations unless a specific exemption has been obtained.

## 3. REQUIREMENTS

3.1 First article. Unless the contractor has furnished armor under this specification within a period of 37 months, the contractor shall submit samples to the contracting officer or his authorized representative for approval in accordance with 4.2.1. The first article ballistic test (see 4.4.1.3) may be waived at the discretion of the procuring activity if the

manufacturer within 37 months has produced acceptable plate within plus and minus 0.250 inch of the thickness (or thicknesses) to be supplied on the contract, provided also that no changes have been made in the processing techniques and other manufacturing conditions.

3.1.1 First time producer. First time producers wishing to qualify to this specification should follow the instructions of 6.4.

3.1.1.1 Change in mill processing. After an armor material has successfully complied with the requirements of this specification, any deliberate change in processing shall be drawn to the attention of the procuring activity. If the material processing is changed, the first article tests may again be required by the procuring activity to assure compliance with the requirements of this specification.

3.2 Chemical composition. Chemical composition shall be within the limits shown in table I. A certification of conformance of the chemical composition of the alloy shall be furnished with the ballistic test plates.

3.3 Mechanical properties. Unless otherwise specified in the contract or order, the mechanical properties of the test specimen taken in the longitudinal direction shall meet the requirements of table II.

3.3.1 If mechanical property requirements differ from those contained in table II or additional properties are specified other than those mentioned in 3.3, the ballistic requirements shall be negotiated between the procuring activity and the supplier.

3.4 Ballistic limit. The protection ballistic limit, BL(P), shall be as specified in appendix A. No ballistic limit shall be specified for plate thickness of 0.250 to 0.499 inch inclusive.

3.5 Stress corrosion resistance. When stress corrosion testing is specified in the contract or order (see 6.2), plate 0.750 inch and over in thickness shall be resistant to stress corrosion cracking, with a minimum of 5 of the 9 specimens showing no evidence of cracking at the end of 96 hours.

3.6 Thermal processing. After final strain hardening performed during plate fabrication, any thermal processing exceeding 200°F (93°C) excluding fabrication by welding will necessitate reverification for conformance to 3.3, 3.4 and 3.5.

3.7 Dimensions. Dimensions shall be as specified in the contract or order (see 6.2).

3.7.1 Tolerances. Unless otherwise specified in the contract or order, the plates submitted for acceptance shall not vary from the specified dimensions by an amount greater than the tolerances shown in ANSI H35.2. Similarly, the thickness tolerance shall be as specified in table III.

TABLE I. Chemical composition, percent. 1/

Alloy	Silicon max.	Iron max.	Copper max.	Manganese	Magnesium	Chromium	Zinc max.	Titanium max.	Other, max. Each Total 2/	Aluminum
5083	0.40	0.40	0.10	0.40-1.0	4.0-4.9	0.05-0.25	0.25	0.15	0.05 0.15	Rem.
5456	0.25	0.40	0.10	0.50-1.0	4.7-5.5	0.05-0.20	0.25	0.20	0.05 0.15	Rem.

1/ Except for "Aluminum" and "others", analysis normally is made for elements for which specific limits are shown.

2/ The sum of those "others" metallic elements 0.010 percent or more each, expressed to the second decimal before determining the sum.

TABLE II. Mechanical properties. 1/

Thickness, inches	Tensile Strength Ksi	Yield Strength, 0.2% Offset Ksi	Elongation percent
0.250 to 0.499, incl.	45.0	35.0	8
0.500 to 2.000, incl.	45.0	37.0	8
2.001 to 3.000, incl.	44.0	35.0	9

1/ See 6.3.

2/ The gage length shall be 1.400 inch for plates having a nominal thickness of 0.500 inch.

TABLE III. Thickness tolerances.

Ordered Thickness, inches	Tolerance, inch	
	minus	plus 1/
0.250 to 0.499, incl.	0.020	-
0.500 to 0.875, incl.	0.030	-
0.876 to 1.125, incl.	0.035	-
1.126 to 1.375, incl.	0.040	-
1.376 to 3.000, incl.	0.045	-

1/ The values for the plus column are derived from the full range of tolerances specified in table 3.1 of ANSI H 35.2 less the value shown in the minus column. For example, the tolerance on a 2.0 inch thick by a 73 inches wide plate would be as follows:

Thickness tolerance (from ANSI H 35.2)	$\pm 0.080''$
Full tolerance less minus tolerance	$0.160 - 0.045 = 0.115''$
Derived plus tolerance	$0.115''$
Tabulated minus tolerance	$0.045''$

3.8 Marking for identification. Each plate shall be marked adjacent to one plate edge with the manufacturer's name or trademark, the basic number of this specification, the plate thickness in inches, the alloy designation and the lot number or code relating to the lot number (see 4.3). The height of the characters shall be 3/8 of an inch or greater. Impression stamping shall not be used unless permitted by the procuring activity.

3.8.1 Ballistic test plates. In addition to the markings in 3.8, each ballistic test plate shall be marked with the letters PRE for First Article test plates and ACC for Acceptance test plates. This marking shall be impression stamped on the edge in letters 3/8 inch high or greater. Ballistic retest plates shall be marked "R1" and "R2" respectively (see A-50.2).

3.9 Ballistic test plate information. A properly executed check list for Armor Data, MIL46027 (figure 1) or equivalent, shall be submitted with each ballistic test plate (see 6.5).

3.10 Workmanship. Plate shall be uniform in quality and clean, smooth and sufficiently free from buckles, blisters, hard spots, damaged ends, laminations and other defects which may affect its use.

#### 4. QUALITY ASSURANCE PROVISIONS

4.1 Responsibility for inspection. Unless otherwise specified in the contract or purchase order, the contractor is responsible for the performance of all inspection requirements (examinations and tests) as specified herein. Except as otherwise specified in the contract or purchase order, the contractor may use his own or any other facilities suitable for the performance of the inspection requirements specified herein, unless disapproved by the Government. The Government reserves the right to perform any of the inspections set forth in this specification where such inspections are deemed necessary to ensure supplies and services conform to prescribed requirements.

4.1.1 Unless otherwise specified in the contract or order, ballistic test plates marked with contract number and lot number shall be forwarded to Commander, CSTA, ATTN: STECS-LI-A, Aberdeen Proving Ground, MD 21005-5059, for ballistic testing (see 6.2).

4.2 Classification of inspection. Inspection shall be classified as follows:

- (a) First article inspection (see 4.2.1).
- (b) Acceptance (production).

4.2.1 First article inspection. First article inspection, except as otherwise indicated in this specification, shall utilize the same requirements and test methods as the production acceptance inspection shown in 4.6.

4.3 Lot. A lot shall consist of all plate of the same alloy and ordered thickness which have been processed together by the same mill practice. The weight of the finished plate in the lot shall not exceed 50,000 pounds and shall be submitted for inspection as a unit.

#### 4.4 Sampling.

##### 4.4.1 Sampling for first article testing.

4.4.1.1 For chemical composition. Samples for chemical analysis shall be removed from each plate selected for ballistic testing and shall meet the requirements when tested as specified in 4.6.1.

4.4.1.2 For mechanical properties. One tension test specimen shall be removed from each plate that has been selected for ballistic testing and shall meet the requirements when tested as specified in 4.6.2.

4.4.1.3 For ballistic test. Two plates, 12 inches by 36 inches of each thickness to be supplied on the contract, shall be submitted for ballistic testing in accordance with appendix A. The orientation of these plates with respect to the rolling direction shall be at the option of the producer.

4.4.1.4 For stress corrosion tests. The stress corrosion test specimens shall be removed from the same plate that has been selected for ballistic testing. The location and type of specimen shall be as specified in 4.6.4.

#### 4.4.2 Sampling for acceptance of production lots.

4.4.2.1 Chemical composition. The sample shall meet the chemical composition requirements when tested as specified in 4.6.1.

4.4.2.1.1 Ingot analysis. At least one sample shall be taken from the molten metal representing the ingots poured as a unit from the same source molten metal. Complete ingot analysis records shall be available to the Government at the producer's facility.

4.4.2.1.2 Product analysis. When sampling has not been made in accordance with 4.4.2.1.1, one sample shall be randomly taken for each 4,000 pounds or less in a lot. Complete product analysis records shall be available to the Government at the contractor's facility.

4.4.2.2 For mechanical properties. Samples for tension tests shall be selected from each lot in accordance with table IV. Each sample shall be randomly selected from a different plate in the lot, and only one tension test specimen shall be made from each sample. The sample shall meet the requirements when tested as specified in 4.6.2.

4.4.2.3 Ballistic testing. One plate, 12 inches by 36 inches, shall be randomly selected from each lot for ballistic testing. The orientation of the plate with respect to the rolling direction shall be at the option of the producer. The sample shall meet the requirements when tested as specified in 4.6.3.

4.4.2.4 For stress corrosion tests. When required (see 6.2), one plate, 12 inches by 12 inches, shall be randomly selected from each lot for stress corrosion testing. The plate shall meet the requirements when tested as specified in 4.6.4.

#### 4.5 Examination.

4.5.1 Visual. Each plate shall be examined for compliance with the identification marking (see 3.8) and workmanship (see 3.10) requirements.

4.5.2 Dimensions. Plates within a lot shall be measured to determine compliance with requirements of paragraph 3.7 in accordance with the sampling procedures approved by the procuring activity (see 6.2).

TABLE IV. Number of tension tests.

Lot size, pounds	Minimum number of samples <u>1/</u>
To 8,000, incl.	2
8,001 to 12,000, incl.	3
12,001 to 20,000, incl.	4
20,001 up	5

1/ If a lot consists of only one plate, one sample shall be required.

4.5.3 Preparation for shipment. Prior to shipment, examination shall be made for compliance with the requirements of section 5.

#### 4.6 Tests.

4.6.1 Chemical composition. Samples for chemical analysis shall be prepared and tested in accordance with method 111 or 112 of FED-STD-151. In case of dispute, analysis by method 111 shall be the basis for acceptance or rejection.

4.6.2 Mechanical properties. Tension test specimens shall be prepared and tested in accordance with ASTM B557. Specimens shall be taken in the longitudinal direction. For material less than 0.500 inch in thickness, a standard rectangular tension test specimen shall be used. From plate in nominal thicknesses less than 0.500 to 1.500 inches, inclusive, tension test specimens shall be taken with the axis midway between the two plate surfaces; from plate in nominal thicknesses greater than 1.500 inches, the axis of the tension test specimen shall be three-fourths of the distance from one surface to the other.

4.6.3 Ballistic testing. Ballistic testing shall be in accordance with appendix A. Test plate thickness, as measured by the ballistic testing agency, shall be used in conjunction with table V and appendix A to determine the test projectile as well as the required V<sub>50</sub> protection ballistic limit. Thickness shall be determined as the average of at least four thickness measurements read on a deep throat micrometer or by means of an ultrasonic device to the nearest 0.001 of an inch and rounded off to the nearest 0.005 of an inch. Measurements shall be made on the intended impact area. In those cases where the BL(P) is within  $\pm 10$  fps of the minimum required value for the measured average thickness (to the nearest 0.005-inch), an interpolation of the appropriate ballistic limit table will be performed. The average plate thickness, computed to the nearest 0.001-inch, will be used to determine the minimum required BL(P).

4.6.4 Stress corrosion. The stress corrosion specimens shall be stressed at 30 Ksi.

4.6.4.1 Capability requirements for resistance to stress corrosion. When stress corrosion testing is required (see 6.2), stress corrosion test specimens shall be prepared and tested in accordance with ASTM G47.



TABLE V. Acceptance ballistic test plates.

Ordered Thickness, Inches	Projectile	Angle of Obliquity in Degrees
0.500 - 0.749	Cal. .30 AP	30
0.750 - 1.000	Cal. .50 FSP	0
1.001 - 1.700 (2 types of projectiles)	20 mm FSP and Cal. .30 AP M2	0
1.701 - 2.000	Cal. .30 AP M2	0
2.001 - 3.000	Cal. .50 AP M2	0

**4.7 Rejection and retest.**

4.7.1 Unless otherwise specified in the contract or order, rejection and retest shall be conducted in accordance with the general section of Fed. Test Method No. 151 (see 6.2).

4.7.2 Ballistic. Rejection and retest of ballistic test plates shall be in accordance with A-50.2.

4.7.3 Stress corrosion. Immediately upon notification of the failure of the specimens, the manufacturer may at his own expense submit thirteen additional specimens for testing. A minimum of seven specimens shall show no cracks at the end of 96 hours when tested as specified in 4.6.4.

4.8 Reduced testing. At the discretion of the procuring activity, the amount of testing may be reduced provided the results on consecutive lots indicate that a uniform product meeting the testing requirements is being produced and providing the manufacturer agrees to maintain the same manufacturing procedures.

**5. PREPARATION FOR DELIVERY**

5.1 Preservation and packaging. Unless otherwise specified in the contract or order, preservation and packaging shall be level C (see 6.2).

5.1.1 Level C. Cleaning, drying, preservation and packaging shall be in accordance with manufacturer's commercial practice.

5.2 Packing. Unless otherwise specified in the contract or order, packing shall be level C (see 6.2).

5.2.1 Level C. Packing shall be in accordance with commercial practice adequate to ensure acceptance and safe delivery by the carrier for the mode of transportation employed.

5.3 Marking. In addition to any special marking required by the contract or order, shipments shall be marked in accordance with the requirements of MIL-STD-129.

## 6. NOTES

(This section contains information of a general or explanatory nature that may be helpful, but is not mandatory.)

6.1 Intended use. The armor specified herein is for military vehicles.

6.2 Ordering data. Procurement documents should specify the following:

- (a) Title, number and date of this specification and choice of alloy.
- (b) Special mechanical properties and ballistic requirements, if required (see 3.3 and 3.3.1).
- (c) When stress corrosion testing is required (see 3.5 and 4.6.4).
- (d) Dimension and tolerance requirements if other than in 3.7.1.
- (e) When impression stamping is permissible (see 3.8).
- (f) Where ballistic testing shall be performed if different than in 4.1.1.
- (g) Dimensional sampling procedure (see 4.5.2).
- (h) Rejection and retest requirement, if other than in 4.7.1.
- (i) Preparation for shipment, if other than in 5.1 and 5.2.
- (j) Additional marking, if required (see 5.3).

6.3 Mechanical properties to ballistic requirements. The minimum mechanical properties specified (see 3.3) may not assure aluminum armor plate meeting the specified ballistic requirements (see 3.4).

6.4 Potential suppliers. Potential suppliers who have not previously supplied armor plate to MIL-A-46027 and wish to have their material ballistically tested may do so at their own expense. It is recommended that inquiries for such testing be directed through a letter to Commander, U.S. Army TECOM, ATTN: AMSTE-TA-O, Aberdeen Proving Ground, MD 21005-5055.

6.5 Forms. Form MIL46027 (see figure 1) may be reproduced and used for submittal of the required data.

6.6 Metric units. When metric dimensions are required, units for inch, foot, foot-pounds and feet per second may be converted to the metric equivalent by multiplying them by the following conversion factors.

<u>English</u>	<u>Multiply by</u>	<u>Equals</u>	<u>Metric SI unit</u>
inch	0.0254	=	metre (m)
foot	0.3048	=	metre (m)
foot-lb	1.3558	=	joule (J)
feet/sec	0.3048	=	(m/s)

Note: Conversion factors can be associated with ASTM E380 entitled "Metric Practice Guide".

6.7 Subject term (key word) listing.

Armor plate	Weldable
Armor	Ballistic Limit
Aluminum	0.30 caliber AP, M2 projectile
Wrought Aluminum	0.50 caliber AP, M2 projectile
5083	0.50 caliber FSP
5456	20 mm FSP

Custodian:  
Army - MR

Preparing activity:  
Army - MR

Review activities:  
Army - AL, AV, TE, AR  
DSA - IS

Project 9535-A039

User activity:  
Army - AT

(KBWP# ID-0949A/DISK-0066A. FOR MTL USE ONLY)

NOTE: This form may be reproduced for data submittal

CHECK LIST FOR ALUMINUM ARMOR DATA						DCASR OR OTHER GOVT. AGENCY			
INSTRUCTIONS: To be filled in by typewriter, carbon reversed or manually with india ink.						Contract			
Prime Contractor:									
Mfg.					Type of Armor _____ Wrought				
Address					Specification MIL-A-46027 _____ Rev. _____ Amend.				
Mfg. Record No. and Date					Firing Date				
Shipping Date					Firing Record No.				
Shipped To					Sample _____ First Article _____ Retest _____ Other				
Purpose _____ Acceptance _____ Development _____ Other _____ Production					Represents _____ lbs.				
Material for Use on (Specific Vehicle)									
TEST ITEM IDENTIFICATION									
Serial Code or Plate No.	Representing Lot No.	Ordered Thick (in.)	Size (L x W)	Alloy No. & Temper					
CHEMICAL ANALYSIS OF SUBMITTED FIRST ARTICLE									
ZN	MG	MN	CU	FE	SI	CR	TI	OTHER - TOTAL	REMAINDER - AL
CHEMICAL COMPOSITION OF PRODUCTION LOT(S): CONFORMS TO SPECIFICATION REQUIREMENTS									
MECHANICAL PROPERTIES									
UTS - Ksi		YS (.2% OFFSET) Ksi		ELONG. 2"		ACT. HARD. TYPE			
Stress Corrosion Test				Date: _____ Signature of Supplier's Representative					
				Date: _____ Signature of Govt. Representative					
BALLISTIC TEST RECORD									
Test	Projectile	Obl. (Degree)	Act. Thks. (in.)	Reqd. Vel. (fps)	Act. Vel. (fps)	Excess Vel. (fps)	Results Passed/Failed	AMCMS Nos.	
Lot Met (failed to meet) the ballistic requirements of Specification MIL-A-46027								TECOM or TRMS No.	
This document consists of _____ Pages				Copy _____ of _____ Copies					
Date _____				Proof Facility Signatures					

FIGURE 1. FORM MIL46027 - Check List for Armor Data (Replaces TAC FORM 3983A for reporting data to MIL-A-46027)

## APPENDIX A

BALLISTIC TESTING OF ALUMINUM ALLOY ARMOR PLATE  
5083 AND 5456

## A-10 SCOPE

A-10.1 Scope. This appendix covers the minimum ballistic limits for acceptable requirements of aluminum alloy armor plate, weldable, 5083 and 5456, when tested in accordance with the provisions of this specification.

## A-20 APPLICABLE DOCUMENTS

A-20.1 The following document forms a part of this appendix: ---

Proving Ground Acceptance Test Procedure No. AAA-PFE-1,  
25 June 1979, for Aluminum Alloy Armor - Plate, Forged,  
Extruded.

(Copies of specifications, standards, handbooks, drawings, and publications required by manufacturers in connection with specific acquisition functions should be obtained from the contracting activity or as directed by the contracting officer.)

## A-30 DEFINITIONS

A-30.1 Fair impact. A fair impact is an impact resulting from the striking of the test plate by a projectile in normal flight (no yawing or tumbling) and separated from another impact or the edge of the plate, hole, crack or spalled area by an undisturbed area of at least two calibers.

A-30.2 Witness plate. A witness plate is normally a 0.014 inch thick sheet of 5052 H36 aluminum alloy (or a 0.020 inch thick sheet of 2024-T3 aluminum alloy) placed six inches behind and parallel to the test plates or other ballistic sample.

A-30.3 Complete penetration, protection, CP(P). A protection complete penetration is a penetration in which the projectile or one or more fragments of a projectile or plate pass beyond the back of the test plate and perforate the witness plate.

A-30.4 Partial penetration, protection, PP(P). A partial penetration is any fair impact that is not a complete penetration.

A-30.5 Gap. A gap is defined as the difference in velocity between the high partial penetration (HPP) velocity and the low complete penetration (LCP) velocity when the HPP velocity is lower than the LCP.

## APPENDIX A

## A-40 REQUIREMENTS

A-40.1 Resistance to penetration. The minimum required V<sub>50</sub> ballistic limit shall be in accordance with the values shown in tables VI through X.

A-50.1 Ballistic tests. Testing shall be in accordance with Proving Ground Acceptance Test Procedure AAA-PFE-1, 25 June 1979, for Aluminum Alloy Armor - Plate, Forged, Extruded, except that nothing in this procedure shall be construed to supersede or invalidate the requirements of this specification.

A-50.1.1 Temperature Conditioning. Prior to the test, the test item(s) will be temperature conditioned at least eight hours. Thermostatic control will be such that the average temperature of the item during the test shall be  $72 \pm 15^{\circ}\text{F}$  ( $22 \pm 8^{\circ}\text{C}$ ).

A-50.1.2 Protection ballistic limit, BL(P).

A-50.1.2.1 Normal circumstances. The BL(P) shall consist of an equal number of fair impact complete and partial penetration velocities attained by the up-and-down firing method. All BL(P)'s shall be computed using the highest partial penetration velocities and the lowest complete penetration velocities. Firing shall continue until either a 4-round BL(P) having a maximum velocity spread of 60 fps or a 6-round BL(P) having a maximum velocity spread of 90 fps has been attained, whichever comes first in the normal sequence of firing. If both occur simultaneously, the 6-round BL(P) will be reported.

A-50.1.2.2 Large zone of mixed results. In the event that the zone of mixed results (difference between the high partial penetration velocity and the low complete penetration velocity, the PP[P] velocity being higher than the low CP[P] velocity) exceeds 90 fps, the firing data will be compared with the specification minimum ballistic requirements. If the lowest complete penetration velocity is equal to or above the minimum specified ballistic limit velocity for the plate thickness, the ballistic limit will be computed on the basis of 4- or 6-rounds using the smallest possible velocity spread. If the lowest complete penetration velocity is below the minimum allowable ballistic limit velocity, then testing will continue until a 10-round ballistic limit has been attained using the smallest possible velocity spread. Ten-round ballistic limits will be reported as such on the armor data firing record.

A-50.1.2.3 Reduction of large velocity gap in borderline cases. If the ballistic limit, which has been determined, is within  $\pm 10$  fps from the minimum allowable ballistic limit and a gap exists which is greater than 25 fps, then another round, or rounds, will be fired to reduce the gap to 25 fps or less. The ballistic limit will then be recomputed using the above criteria. The recomputed BL(P) will be reported as the BL(P) of the plate (in borderline cases, a reduction of the gap between the high partial penetration velocity and the low complete velocity should result in a better evaluation of the BL(P)).

## APPENDIX A

A-50.2 Rejection and retest of ballistic plates.

A-50.2.1 First article tests (rejection). Unless otherwise specified in the contract or order, failure of any of the first article test plates to meet the minimum ballistic requirements shown in the appendix of this specification indicates failure of the product and process.

A-50.2.2 First article (retests). Resubmission of ballistic retest plates shall not be made until the manufacturer has made the necessary corrections in the processing of the material to the satisfaction of the procuring activity. Two retest plates shall be submitted for first article testing, and both tests must pass; otherwise, the armor material shall be rejected.

A-50.2.3 Acceptance tests (rejection). Unless otherwise specified in the contract or order, failure of a test plate to meet the ballistic requirements indicates failure of the lot; however, the final decision will depend on the outcome of retests, if submitted.

A-50.2.4 Acceptance tests (retests). If a test plate representing a lot fails to meet the ballistic requirement, the manufacturer, upon notification of the failure may submit at his own expense two additional test plates from the same lot for ballistic retest. If either of these plates fail the ballistic test, the lot shall be rejected. The manufacturer may elect to resubmit the lot after retreatment of the entire lot by submitting two additional test plates. If either of these plates fail, the lot shall be permanently rejected.

A-50.3 Disposition of ballistic test plates.

A-50.3.1 First article test plates. Upon request of the applicant within 15 days after ballistic testing, first article plates will be returned "as is" to the applicant, at his expense, unless the plates were destroyed in testing.

A-50.3.2 Acceptance test plates. Acceptance test plates that comply with the requirements of this specification are considered as part of the lot they represent, and ownership of the test plates passes to the Government with the acceptance of that lot. Acceptance test plates that fail to comply with the requirements of this specification are considered as part of the lot they represent and remain the property of the producer just as the rejectable lot does. The failed plates will be returned, upon request, as in A-50.3.1.

## APPENDIX A

TABLE VI. Minimum required ballistic limits - caliber .30 AP  
M2 projectiles at 30° obliquity.

Thickness, in.	Required BL(P), fps	Thickness, in.	Required BL(P), fps	Thickness, in.	Required BL(P), fps
0.460	1290	0.560	1438	0.660	1573
0.465	1298	0.565	1445	0.665	1580
0.470	1305	0.570	1452	0.670	1586
0.475	1313	0.575	1459	0.675	1593
0.480	1321	0.580	1466	0.680	1599
0.485	1328	0.585	1473	0.685	1605
0.490	1336	0.590	1480	0.690	1612
0.495	1343	0.595	1487	0.695	1618
* 0.500	1351	0.600	1494	0.700	1624
0.505	1358	0.605	1500	0.705	1630
0.510	1366	0.610	1507	0.710	1637
0.515	1373	0.615	1514	0.715	1643
0.520	1381	0.620	1521	0.720	1649
0.525	1388	0.625	1527	0.725	1655
0.530	1395	0.630	1534	0.730	1661
0.535	1402	0.635	1541	0.735	1668
0.540	1410	0.640	1547	0.740	1674
0.545	1417	0.645	1554	0.745	1680
0.550	1424	0.650	1560	** 0.749	1685
0.555	1431	0.655	1567	0.750	1686

\* Specification Requirements begin for this Ordered Thickness.

\*\* Specification Requirements end for this Ordered Thickness.



## APPENDIX A

TABLE VII. Minimum required ballistic limits - caliber .50 fragment  
simulating projectiles at 0° obliquity.

Thickness, in.	Required BL(P), fps	Thickness, in.	Required BL(P), fps	Thickness, in.	Required BL(P), fps
0.720	1681	0.835	2046	0.950	2485
0.725	1696	0.840	2064	0.955	2506
0.730	1711	0.845	2081	0.960	2527
0.735	1725	0.850	2099	0.965	2549
0.740	1740	0.855	2117	0.970	2570
0.745	1755	0.860	2135	0.975	2592
* 0.750	1770	0.865	2153	0.980	2614
0.755	1785	0.870	2171	0.985	2636
0.760	1801	0.875	2190	0.990	2658
0.765	1816	0.880	2209	0.995	2680
0.770	1832	0.885	2227	** 1.000	2703
0.775	1848	0.890	2246	1.005	2726
0.780	1863	0.895	2265	1.010	2749
0.785	1879	0.900	2284	1.015	2772
0.790	1895	0.905	2304	1.020	2795
0.795	1912	0.910	2323	1.025	2819
0.800	1928	0.915	2343	1.030	2842
0.805	1945	0.920	2363	1.035	2866
0.810	1961	0.925	2383	1.040	2890
0.815	1978	0.930	2403	1.045	2914
0.820	1995	0.935	2423	1.050	2939
0.825	2012	0.940	2444	1.055	2963
0.830	2029	0.945	2464	1.060	2988

\* Specification Requirements begin for this Ordered Thickness.

\*\* Specification Requirements end for this Ordered Thickness.

## APPENDIX A

TABLE VIII. Minimum required ballistic limits - 20 mm fragment  
simulating projectiles at 0° obliquity.

Thickness, in.	Required BL(P), fps	Thickness, in.	Required BL(P), fps	Thickness, in.	Required BL(P), fps
0.995	1412	1.195	1745	1.395	2153
* 1.001	1420	1.200	1755	1.400	2165
1.005	1427	1.205	1764	1.405	2176
1.010	1435	1.210	1773	1.410	2187
1.015	1443	1.215	1783	1.415	2199
1.020	1450	1.220	1792	1.420	2210
1.025	1458	1.225	1801	1.425	2222
1.030	1466	1.230	1811	1.430	2234
1.035	1474	1.235	1821	1.435	2245
1.040	1481	1.240	1830	1.440	2257
1.045	1489	1.245	1840	1.445	2269
1.050	1497	1.250	1849	1.450	2281
1.055	1505	1.255	1859	1.455	2293
1.060	1513	1.260	1869	1.460	2305
1.065	1521	1.265	1879	1.465	2317
1.070	1529	1.270	1889	1.470	2329
1.075	1537	1.275	1899	1.475	2341
1.080	1546	1.280	1909	1.480	2353
1.085	1554	1.285	1919	1.485	2366
1.090	1562	1.290	1929	1.490	2378
1.095	1570	1.295	1939	1.495	2390
1.100	1579	1.300	1949	1.500	2403
1.105	1587	1.305	1959	1.505	2415
1.110	1596	1.310	1970	1.510	2428
1.115	1604	1.315	1980	1.515	2441
1.120	1613	1.320	1991	1.520	2453
1.125	1621	1.325	2001	1.525	2466
1.130	1630	1.330	2012	1.530	2479
1.135	1638	1.335	2022	1.535	2492
1.140	1647	1.340	2033	1.540	2505
1.145	1656	1.345	2043	1.545	2518
1.150	1664	1.350	2054	1.550	2531
1.155	1673	1.355	2065	1.555	2544
1.160	1682	1.360	2076	1.560	2558
1.165	1691	1.365	2087	1.565	2571
1.170	1700	1.370	2098	1.570	2585
1.175	1709	1.375	2109	1.575	2598
1.180	1718	1.380	2120	1.580	2612
1.185	1727	1.385	2131	1.585	2625
1.190	1736	1.390	2142	1.590	2639

## APPENDIX A

TABLE VIII. Minimum required ballistic limits - 20 mm fragment  
simulating projectiles at 0° obliquity. (Continued)

Thickness, in.	Required BL(P), fps	Thickness, in.	Required BL(P), fps	Thickness, in.	Required BL(P), fps
1.595	2653	1.635	2765	1.675	2882
1.600	2666	1.640	2780	1.680	2897
1.605	2680	1.645	2794	1.685	2912
1.610	2694	1.650	2809	1.690	2928
1.615	2708	1.655	2823	1.695	2943
1.620	2722	1.660	2838	** 1.700	2958
1.625	2737	1.665	2853	1.705	2973
1.630	2751	1.670	2867		

\* Specification Requirements begin for this Ordered Thickness.

\*\* Specification Requirements end for this Ordered Thickness.

## APPENDIX A

TABLE IX. Minimum required ballistic limits - caliber .30  
AP M2 projectiles at 0° obliquity.

Thickness, in.	Required BL(P), fps	Thickness, in.	Required BL(P), fps	Thickness, in.	Required BL(P), fps
* 1.001	1817	1.200	2050	1.400	2259
1.005	1823	1.205	2055	1.405	2264
1.010	1829	1.210	2060	1.410	2269
1.015	1836	1.215	2066	1.415	2274
1.020	1842	1.220	2071	1.420	2279
1.025	1848	1.225	2077	1.425	2283
1.030	1854	1.230	2082	1.430	2288
1.035	1860	1.235	2088	1.435	2293
1.040	1866	1.240	2093	1.440	2298
1.045	1872	1.245	2098	1.445	2303
1.050	1878	1.250	2104	1.450	2308
1.055	1884	1.255	2109	1.455	2313
1.060	1890	1.260	2114	1.460	2318
1.065	1896	1.265	2120	1.465	2323
1.070	1902	1.270	2125	1.470	2328
1.075	1907	1.275	2130	1.475	2332
1.080	1913	1.280	2136	1.480	2337
1.085	1919	1.285	2141	1.485	2342
1.090	1925	1.290	2146	1.490	2347
1.095	1931	1.295	2151	1.495	2352
1.100	1937	1.300	2157	1.500	2356
1.105	1942	1.305	2162	1.505	2361
1.110	1948	1.310	2167	1.510	2366
1.115	1954	1.315	2172	1.515	2371
1.120	1960	1.320	2177	1.520	2376
1.125	1965	1.325	2183	1.525	2380
1.130	1971	1.330	2188	1.530	2385
1.135	1977	1.335	2193	1.535	2390
1.140	1983	1.340	2198	1.540	2394
1.145	1988	1.345	2203	1.545	2399
1.150	1994	1.350	2208	1.550	2404
1.155	2000	1.355	2213	1.555	2409
1.160	2005	1.360	2218	1.560	2413
1.165	2011	1.365	2223	1.565	2418
1.170	2016	1.370	2229	1.570	2423
1.175	2022	1.375	2234	1.575	2427
1.180	2027	1.380	2239	1.580	2432
1.185	2033	1.385	2244	1.585	2437
1.190	2038	1.390	2249	1.590	2441
1.195	2044	1.395	2254	1.595	2446

## APPENDIX A

TABLE IX. Minimum required ballistic limits - caliber .30  
AP M2 projectiles at 0° obliquity. (Continued)

Thickness, in.	Required BL(P), fps	Thickness, in.	Required BL(P), fps	Thickness, in.	Required BL(P), fps
1.600	2450	1.760	2594	1.920	2730
1.605	2455	1.765	2598	1.925	2734
1.610	2460	1.770	2603	1.930	2738
1.615	2464	1.775	2607	1.935	2742
1.620	2469	1.780	2611	1.940	2746
1.625	2473	1.785	2616	1.945	2751
1.630	2478	1.790	2620	1.950	2755
1.635	2482	1.795	2624	1.955	2759
1.640	2487	1.800	2629	1.960	2763
1.645	2492	1.805	2633	1.965	2767
1.650	2496	1.810	2637	1.970	2771
1.655	2501	1.815	2641	1.975	2775
1.660	2505	1.820	2646	1.980	2779
1.665	2510	1.825	2650	1.985	2783
1.670	2514	1.830	2654	1.990	2787
1.675	2519	1.835	2658	1.995	2791
1.680	2523	1.840	2663	** 2.000	2796
1.685	2528	1.845	2667	2.005	2800
1.690	2532	1.850	2671	2.010	2804
1.695	2537	1.855	2675	2.015	2808
1.700	2541	1.860	2680	2.020	2812
1.705	2545	1.865	2684	2.025	2816
1.710	2550	1.870	2688	2.030	2820
1.715	2554	1.875	2692	2.035	2824
1.720	2559	1.880	2697	2.040	2828
1.725	2563	1.885	2701	2.045	2832
1.730	2568	1.890	2705	2.050	2836
1.735	2572	1.895	2709	2.055	2840
1.740	2576	1.900	2713	2.060	2844
1.745	2581	1.905	2717	2.065	2848
1.750	2585	1.910	2722	2.070	2852
1.755	2590	1.915	2726		

\* Specification Requirements begin for this Ordered Thickness.

\*\* Specification Requirements end for this Ordered Thickness.

## APPENDIX A

TABLE X. Minimum required ballistic limits - caliber .50  
AP, M2 projectiles at 0° obliquity.

Thickness, in.	Required BL(P), fps	Thickness, in.	Required BL(P), fps	Thickness, in.	Required BL(P), fps
1.950	2041	2.150	2174	2.350	2299
1.955	2045	2.155	2177	2.355	2303
1.960	2048	2.160	2180	2.360	2306
1.965	2051	2.165	2184	2.365	2309
1.970	2055	2.170	2187	2.370	2312
1.975	2058	2.175	2190	2.375	2315
1.980	2062	2.180	2193	2.380	2318
1.985	2065	2.185	2196	2.385	2321
1.990	2068	2.190	2200	2.390	2324
1.995	2072	2.195	2203	2.395	2327
* 2.001	2075	2.200	2206	2.400	2330
2.005	2079	2.205	2209	2.405	2333
2.010	2082	2.210	2212	2.410	2336
2.015	2085	2.215	2216	2.415	2339
2.020	2089	2.220	2219	2.420	2342
2.025	2092	2.225	2222	2.425	2345
2.030	2095	2.230	2225	2.430	2348
2.035	2099	2.235	2228	2.435	2351
2.040	2102	2.240	2231	2.440	2354
2.045	2105	2.245	2234	2.445	2357
2.050	2109	2.250	2238	2.450	2360
2.055	2112	2.255	2241	2.455	2363
2.060	2115	2.260	2244	2.460	2366
2.065	2119	2.265	2247	2.465	2369
2.070	2122	2.270	2250	2.470	2372
2.075	2125	2.275	2253	2.475	2375
2.080	2128	2.280	2256	2.480	2378
2.085	2132	2.285	2259	2.485	2380
2.090	2135	2.290	2263	2.490	2383
2.095	2138	2.295	2266	2.495	2386
2.100	2142	2.300	2269	2.500	2389
2.105	2145	2.305	2272	2.505	2392
2.110	2148	2.310	2275	2.510	2395
2.115	2151	2.315	2278	2.515	2398
2.120	2155	2.320	2281	2.520	2401
2.125	2158	2.325	2284	2.525	2404
2.130	2161	2.330	2287	2.530	2407
2.135	2164	2.335	2290	2.535	2410
2.140	2168	2.340	2293	2.540	2413
2.145	2171	2.345	2296	2.545	2416

## APPENDIX A

TABLE X. Minimum required ballistic limits - caliber .50  
AP, M2 projectiles at 0° obliquity. (Continued)

Thickness, in.	Required BL(P), fps	Thickness, in.	Required BL(P), fps	Thickness, in.	Required BL(P), fps
2.550	2419	2.735	2524	2.920	2625
2.555	2421	2.740	2527	2.925	2628
2.560	2424	2.745	2529	2.930	2630
2.565	2427	2.750	2532	2.935	2633
2.570	2430	2.755	2535	2.940	2636
2.575	2433	2.760	2538	2.945	2639
2.580	2436	2.765	2541	2.950	2641
2.585	2439	2.770	2543	2.955	2644
2.590	2442	2.775	2546	2.960	2647
2.595	2445	2.780	2549	2.965	2649
2.600	2447	2.785	2552	2.970	2652
2.605	2450	2.790	2554	2.975	2654
2.610	2453	2.795	2557	2.980	2657
2.615	2456	2.800	2560	2.985	2660
2.620	2459	2.805	2563	2.990	2662
2.625	2462	2.810	2565	2.995	2665
2.630	2465	2.815	2568	** 3.000	2668
2.635	2468	2.820	2571	3.005	2670
2.640	2470	2.825	2574	3.010	2673
2.645	2473	2.830	2576	3.015	2676
2.650	2476	2.835	2579	3.020	2678
2.655	2479	2.840	2582	3.025	2681
2.660	2482	2.845	2585	3.030	2684
2.665	2485	2.850	2587	3.035	2686
2.670	2487	2.855	2590	3.040	2689
2.675	2490	2.860	2593	3.045	2691
2.680	2493	2.865	2595	3.050	2694
2.685	2496	2.870	2598	3.055	2697
2.690	2499	2.875	2601	3.060	2699
2.695	2501	2.880	2604	3.065	2702
2.700	2504	2.885	2606	3.070	2704
2.705	2507	2.890	2609	3.075	2707
2.710	2510	2.895	2612	3.080	2710
2.715	2513	2.900	2614	3.085	2712
2.720	2516	2.905	2617	3.090	2715
2.725	2518	2.910	2620	3.095	2717
2.730	2521	2.915	2622	3.100	2720

\*Specification Requirements begin for this Ordered Thickness.

\*\* Specification Requirements end for this Ordered Thickness.

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